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Abstract:

China's effort in the past two decades to develop technological entrepreneurship by means of establishing science parks and business incubators is unique in terms of both its large scale and the speed with which this has been achieved. This paper attempts to contribute on the understanding of China's technological entrepreneurship promotion programs by positioning their policies and practice against an international context where the governance model appears to show much variation. Distinctive features identified for China after a broad comparison, however, draw attention to two major discrepancies between policy discourse and practice: 1) contrary to the claims of central policy makers that science parks were established to help nurture capabilities in domestic corporations, it has becoming increasingly clear that foreign direct investment (FDI) is considered the key to their success; 2) instead of being embedded in the local milieu as an interface for R&D, industry and education, technology transfer and commercialization in business incubators still heavily rely on funds and subsidies from the central government, and thus barely contribute to local entrepreneurship development.

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Bio Statement:

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Introduction

Entrepreneurship has long been seen as having a central role in the long-run process of technology change, thus a major driving force behind sustained economic growth (Baumol, 2002; Schumpeter and Opie, 1934). Since the mid 1980s, entrepreneurship has been linked to the emergence of new, high-tech sectors in advanced industrialized countries, particularly in a sense that it constitutes a vital catalyst for successful linkages between research and production (Acs, 2004; Audretsch and Keilbach, 2005). Today, industry relies more and more on academic research for generating marketable innovation while successful innovation is dependent on the existence of entrepreneurship to enable the introduction of a new technology into the market. In other words, there is an increasing demand for technological entrepreneurship (Baark, 1994).

The legendary story of Silicon Valley and Route 128 in the U.S., whose defining characteristic is the clustering of high-technology firms and the synergies it creates among various institutions in the cluster, has spurred the interest and belief that science parks and their affiliated business incubators are the most efficient policy tools to nurture technological entrepreneurship, in terms that they can not only provide an interface between universities, R&D and production activities but also are conducive to the promotion of network environments where industry agglomeration and the exchange of ideas can take place (Hu, 2007; Komninos, 1997; Sutherland, 2005). As a consequence, although neither Silicon Valley nor Route 128 was a deliberate product of government policy, countries around the world, developed or under-developed, have attempted to emulate the American success stories by offering policy incentives to encourage high-technology firm formation in designated locations. Better known examples of such parks comprise Cambridge, U.K., Tsukuba in Japan, Taiwan's Tsinchu Technology Park and the ZhongGuanCun in China.

As in many other developed and developing nations, the science and technology industry parks as the Chinese variant of science parks, together with their on site

technology business incubators, have experienced a conspicuous growth since the late 1980s (Harwit, 2002; Lalkaka, 2003). This paper, in response, considers China's approach to develop its own science parks and technology business incubators as part of a plan to foster technological entrepreneurship and reform its innovation system in a comparative context. It finds that, unsurprisingly, China's highly pragmatic economic reform, particularly the asymmetric decentralization process (Chien and Gordon, 2008), has seriously diverted its science parks and business incubators from their primary objectives into a stronger bias towards production of export oriented high-tech manufactures, which sharply contrasts against those found in the West.

The next sections of this paper will first review the history of science parks and business incubators development in 'Western' context, within the U.S. and Western Europe, aiming to identify those general as well as contingent governance factors that have affected their performance; then consider the Chinese case in rather more depth and how its uniqueness may be better understood. Because its purpose is to frame a comparative analysis, this paper has avoided close engagement either with the empirical literature or with overlapping sets of theoretical reasoning, in the interest of developing a clearer line of argument to highlight contextual factors that might generate significantly different versions of governance in the nurturing of technological entrepreneurship.

Significant Features of Western Experiences

The governance of technology entrepreneurship development has charted different paths in the U.S. and in Western Europe. In the American case, as a spontaneous response to the industry demand and the pressures of territorial competition, science parks and business incubators were both first created in the 1950s[1]. While the science parks have clearly committed themselves to local communities' demand of technology advancement and spillovers, business incubators were actually a mean to revitalize declining manufacturing areas in the beginning and offered services to all kinds of

enterprises, from low-tech to no-tech, as a tool for reconversion (Aernoudt, 2004). However, during the proliferation of business incubators since the late 1970s, technology and the capacity to conduct research were increasingly recognized as the core factors in growth and development, thus the so-called technology incubators started to take a significant share in new incubation programs while half of them were developed around specific industrial and technological clusters such as biotechnology, information technology, environmental technology, or, speech technology in associated science parks (Lalkaka, 2002; Sutherland, 2005). This explains how 'science parks' and 'incubators' have become inseparable terms when people refer to technological entrepreneurship promotion instruments nowadays.

Throughout the whole aforementioned process, which apparently happened prior to the prevalence of the National Innovation System (NIS) theory (Freeman, 1987; Lundvall, 1992; R. R Nelson, 1993), the U.S. were barely informed of the role that a government 'should' play in the respect of promoting technological entrepreneurship. Rather, as usual, strong market demands from associated industries and the localized economic interest in entrepreneurship again provided essential impetus for the widespread trial and acceptance of science parks and technology incubators (Giesecke, 2000). In a context with no real experience of top-down spatial policy, except briefly and partially during the Great Depression in 1930s, there is a focus of locality on the promotion of economic initiatives such as the establishment of a science park in U.S. Therefore, on one hand, the construction of science parks in U.S. has been mostly regarded as a pure continuation of private market processes 'by innovative means'; on the other hand, their popularity reflected the unabashed competition among those host regions for technology and investment by engaging in extensive mimicry of each others' initiatives. Such a combination of industry incentives and local interests on the U.S. fertile entrepreneurship soil, in result, has yielded by far the most effective and competitive governance model of science parks and technology incubators across the world (Kuhlmann, 2001; Malik and Cunningham, 2006; Richard R. Nelson, 2008).

The development of Science Parks in Western Europe clearly received its early

impetus from the United States' experience. As an illustration, there is a clear link between observing the early success of a Science Park at Stanford, CA and its replication in Cambridge, UK. There is, however, a considerable time lag between the establishment of the Stanford Park in the 1950s and the establishment of the Cambridge Science Park, Sophia Antipolis in France and Haasroed in Belgium in the late 1960s. Like their predecessors in U.S., these early science parks were largely initiatives of universities and the private sector. In contrast, by the 1980s a second much larger wave of government-supported construction took off. Unlike the first wave, the second was also linked to broader economic and political change and was marked by the rise of new types of economic activity in new high-tech industries – first of all, the advantage position of U.S. and Japan in technology competitiveness as well as the emergence and prevalence of the NIS theory, together inspired Western European countries to overcome their backwardness and inherent deficiencies in innovation capability by exploiting 'innovation policies' (Kuhlmann, 2001); Secondly, the progress of trade liberalization with the European Union (EU) has conspicuously reversed the orientation of spatial economic policies in Western Europe, from nationally based top-down 'regional policies', with a strong emphasis on spatial equity and political cohesion, toward a bottom-up focus, in which initiatives such as the interests on science parks emerged from particular places, each pursuing their own economic interests (Chien and Gordon, 2008).

One of the first business incubators in Europe was set up by UK in 1975, when British steel formed a subsidiary to create jobs in steel closure areas. Similar to the U.S. experience, business incubators in Western Europe first became an instrument to promote a more diversified base for regional economies and later became a tool for improving regional competitiveness by fostering the emergence of technology-based firms in the ear of the New Economy (Aernoudt, 2004; Storey and Tether, 1998; Sutherland, 2005). Since the early 1980s, business incubators tended to seek closer contacts with the centers of knowledge creation such as universities, MNCs' R&D departments and public research institutions, which could be easily found within

science parks. In Germany for instance, the University of Berlin established its first business incubators in 1983, aimed at facilitating the transfer of research findings to industry. France followed in 1985 creating an incubator within the Sophia Antipolis Technology Park. As a result, similar to the host science parks, it is rather difficult to construct a generalized overview of the European business incubator scene because of the diversified regional objectives these incubators have served in the name of fostering technological entrepreneurship: in Belgium and Spain, the focus was initially to attract branches of multinational firms, in Germany the targets was clearly innovative startups, in France and the Netherlands incubators were mostly located in university science parks to assist the filing of patents (Aernoudt, 2004).

The governance of technological entrepreneurship in Western Europe, in contrast to the U.S. case, appeared to be distinctively stimulated by the strong government response to the steadier shift to a post-industrial economy, which was additionally strengthened by the presence of the NIS theory (Georghiou, 2001; Giesecke, 2000; Goldfarb and Henrekson, 2003; Shapira et al., 2001). The enormous growth rate of science parks and business incubators in Europe indentified by relevant empirical studies (Giesecke, 2000; Komninos, 1997; Storey and Tether, 1998; Sutherland, 2005) manifests a policy-driven catch-up strategy, wherein European countries are striving to exploit on the proliferation of technological entrepreneurship as the U.S. does. Although there are long-running debates concerning the degree to which it is legitimate for governments to intervene in the economy in support of innovation, the belief in NIS theory and especially the recognition of the existence of market and system failures in European societies (Edler and Georghiou, 2007), finally results in an active, direct and interventionist governance model of science parks and business incubators development in Europe. Besides those individual national approaches, coordinated initiatives were taken at the EU level as well. In 1984 the EU began a European Business Innovation Network (EBN). Since then, 150 Business Innovation Centers (BICs) have developed across 20 countries. BICs are incubator-like organizations providing consultancy, taking part in technology transfers and

organizing training sessions mainly for technology-based firms. To this date, BICs account for nearly two-thirds of the technology business incubators in Italy, France, Spain, and Portugal (Aernoudt, 2004).

Notwithstanding such important differences in the governance of technological entrepreneurship, there is of course a great deal in common between the two continents, most notably the representation of local coalitions' economic interests, buttressed by pluralistic political processes and openly competitive elections, and an expectation that innovation and technology transfer activities should constitute the nucleus of science parks and business incubators. Although government intervention has mobilized the rapid expansion of technological entrepreneurship promotion programs in Europe, a consensus formed within important local stakeholders such as universities, industrial associations and labor unions is still indispensable before the full operation of a science park or an incubator, which is subject to its longstanding pluralistic democracy tradition that also applies in the U.S. context. In addition, the governments' intention to abuse science parks and business incubators for their own particular interest, e.g. generating more tax revenue by merely selling lands and hosting large MNCs, which has occasionally presented both in the U.S. and the Western Europe (Chien and Gordon, 2008; Cooke, 2001), tends to be ultimately rectified because of the local coalitions' concerted claim on the expectation of associated programs, viz. the interface between research and industry.

It is yet very difficult to assess Europe's catch-up performance in the governance of technological entrepreneurship compared to the first mover, the U.S. However, a noticeable and widely believed criticism is that despite the governments' strong intervention and the active responses from the local coalitions, the links between higher education and research institutes and science parks and business incubators remained weak in Europe and this restrains considerably their capabilities to supply technologies and innovation services (Felsenstein, 1994; Quintas and Massey, 1992; Sutherland, 2005; Westhead and Storey, 1994). Seen from this light, Geisecke (2000) concluded that government itself can not create all elements of a favorable 'economic

ecology' for technological entrepreneurship: a system of variables that constitute the innovation system around science parks and incubators is too complex to be anticipated by government actors in advance; the existence of these determinants, and more importantly, the efficacy of governmental attempts to cultivate them, always vary across political, historical and cultural idiosyncrasies.

Science Parks and Business Incubators in China

China launched on a series of science and technology policy initiatives at the beginning of the reform era in an attempt to boost its science and technology capabilities. Some of these focused on basic research such as the establishment of the Key National Laboratories; others, such as the Tackle (Gong Guan) Program, were geared towards serving the immediate technological needs of Chinese industries. The "863" Plan[2], or the High Technology Research and Development Plan, on the other hand, aimed to bridge China's gap with the world frontier in a select few new and high technological areas, such as biotechnology, electronics, and information technology. Meanwhile, given the legacy of the centrally planned system in which scientific research and production were not closely coupled (Simon, 1989), 'developing closer ties' was particularly highlighted as an important policy objective.

The Development of China's Science Parks and Business Incubators

In recognition of the lack of institutions that would support new- and high-technology firm formation and other mechanisms of technological diffusion, the Torch Program was put in place in 1988 with the main objective to develop high- and new-technology products, establish technology-oriented enterprises, and pave the way for the commercialization of innovations that will come out of major national science and technology programs. A major ingredient of the Torch Program was the establishment of science parks[3], where most of the new- and high- technology commercialization efforts were expected to take place and where such efforts were to receive various forms of government subsidies. In March 1991, the State Council approved the

establishment of 27 science parks, followed by yet another 25 in the following year. The establishment of the Yanglin Agricultural Technology Park in the western Chinese province of Shannxi in 1997 brings the total number of national science parks to 53. In the meantime, a large number of science parks have also been established by various levels of local government. These parks do not usually apply the same relatively stringent criteria that the national parks use to certify the high-technology status of firms in the park. It is plausible that these local parks operate on a different mechanism from the national parks. Therefore, this paper focuses on the experiences and lessons from the national science parks.

The Torch Program, as well as overseeing general park development, has also been responsible for the development of technology business incubators, known as high-tech innovation centers (ICs) in China. These are usually based within the park zones, often in a dedicated building. The impetus to create ICs was driven by the conviction among China's authorities that the 3,000 or so business incubators found world wide have greatly contributed to the development of technological entrepreneurship and the knowledge economy and that they are sure to play a more important role in the twenty-first century. Just as innovation centers have grown up around successful science parks in the west, Chinese policy makers looked to emulate this trend.

With encouragement from the UNDP, the first incubator, the Wuhan Donghu Innovation Centre, was approved in 1987. After this the ICs started to quickly grow on the back of the Torch Program's support. Their growth, therefore, has basically been a top down initiative, in which the science parks have been specifically assigned and instructed to build and run incubators. Within 20 years, by the end of 2007, the Torch Program has established and certified 548 ICs at a stunning speed (MOST, 2007).

Despite the preceding efforts, based on the recent observations from the limited empirical literatures which shed light on China's science parks and business incubators (Hu, 2007; Ma and Goo, 2005; Sutherland, 2005; Walcott, 2003), it is

argued that the most noticeable feature of the parks is that they have become increasingly oriented to the wholesale importation of foreign technology, in the form of inward investment, as opposed to promotion of indigenous firms and technologies via institutional reform. As a result the most striking feature of the park areas is their importance to China's total industrial production and export rather than the restructuring of its innovation system (see table 1). This is perhaps unsurprising given China's highly pragmatic approach to economic reform, especially given the lessons drawn from the Western Europe's experience—domestic context, particularly domestic politics, institutions, and norms will strongly molds the manner in which regulatory reinvention is realized in practice. It is perhaps banal to point out that this disconnection between aspiration and practice also holds for China in addition to the precedent in Europe. What is more useful here is to attempt to explain the unique sources of this divergence for the improvement of governance in China.

[Table 1 here]

Governing Technological Entrepreneurship: the Chinese Style

As with many reforms in China, the promotion of science parks initially looked to borrow from what were considered the successful experiences of other nations. The science park model was considered particularly suitable and attractive. This is because the model offered the possibility that a region with no prior industrial history could make a direct leap to a leading-edge industrial economy, given the right set of circumstances, without the time and effort required to pass through any intermediate stages of development (Sutherland, 2005). As reforms have unfolded, however, idiosyncrasies of the country started to reshape its program's profile. Among them, the following economic and political factors appear to be most influential:

The national development strategy. As in Europe, shifting competitive pressures and closer integration into an international economy were key structural influences on the

growth of science parks in China, though both worked quite differently in the Chinese context. Thus, whereas in Europe the shift towards a more flexible, post-Fordist, post-industrial economy, with a greater emphasis on quality competition was an important factor, the Chinese context was of industrialization, price competition and an emergent kind of Fordism. Therefore, the Chinese government's early enthusiasm on science parks and ICs initially reflected a foresight that is ahead of its development stage.

However, while traditional manufacturing sectors gradually start to experience declining terms of trade and the high-technology sectors are increasingly seen as the most dynamic areas of global demand, Chinese government was pressured to desire a radical update of its export structure by moving away from labor-intensive low value-added manufactures (for which special economic zones became renowned). In order to gear its export trade towards the high-tech sector, Chinese leaders hope to raise the contribution from high-tech exports by four-fold by 2010 and account for over 30 percent of total export, bringing China's export structure closer in line with that of developed nations. As an immediate response, the central government rapidly integrated the science parks into China's overall trade strategy. In early 2000, the Ministry of Science and Technology and Ministry of Foreign Trade approved 16 of the 53 state level parks as a trial group of high-tech export bases.

As a consequence, a distinguishing feature of China's parks has been shaped, in keeping with the imposed command of the central government and the national trade strategy, viz. they produce a disproportionately high share of high-tech goods for export. Further, in order to accomplish this radical trade and production expansion, China's parks had to heavily depend on foreign direct investment (FDI) rather than counting on China's own scientific, technological and economic strength.

Asymmetric decentralization and the FDI fever of local governments. A salient similarity in the Western model of technological entrepreneurship's governance is the representation of local entities' interests and petitions throughout the decision making

process, which stems from its pluralistic democracy tradition. The appearance of the science parks and business incubators in China, where provincial and city governments are acknowledged to have played a key role in rapid recent growth marks a notable exception then. For, despite substantial liberalization of external economic relations and a burgeoning domestic private sector, the country remains an authoritarian Communist society. Top officials and cadres of sub-national governments are not elected locally but appointed and removed by upper level governments, on the basis of a quite systematic screening of candidates' credentials, among which, since the early 1980s increasing weight has been given to objective assessments of concrete economic achievements in terms of local GDP growth, FDI attraction and revenue generation (Oi, 1995). Performance-based personnel management served to trigger careerism as a political incentive for local leaders to pursue stronger economic development. The more growth, the better are the chances to get advancement, with increasing power and other rewards.

Consequently, local governments since the reform all strove to accrue the greatest amount of resources, bargaining for the most favorable policy concessions and seeking to generate the highest growth rates. This race among local governments focused very heavily on inward investment rather than promotion of competitive advantage for local firms, since the former may result in immediate FDI and GDP achievements within the ambitious local leader's prefecture. Accordingly, when the central government has forsaken its original target of nurturing technological entrepreneurship in indigenous Chinese corporations in science parks, local governments exhibited few interests to defend the root of their regional competitiveness in the long-run. On the contrary, local officials competed with each other on more preferential policies devised to attract MNCs while leaving these firms with greater negotiating power and considered themselves as essentially sales people responsible for selling their parks to investors, in order to cash out their land for more revenue (Chien and Gordon, 2008; Sutherland, 2005).

Meanwhile, despite economic liberalization, relations between governments/

official and society/ industry, university and research institution/ professional consultants remain asymmetric in political terms. Incrementally, local governments in China have displayed more external interests in an attempt to unleash the economic dynamism of societal groups, but in a way that directs that power toward its own goals. In result, other local entities still have negligible influence over the direction and pace of the development of science parks, because of the public sector's overwhelming control of policy, financial leverage and land leasing. Such an unbalanced situation between local governments and societies again set the Chinese case and the West model apart, impeding China's science parks to create synergies in the local milieu (Hu, 2007).

The policy duality. Complementing the development of large-scale high-tech industrial production, a second purpose of the parks has been to promote dozens of ICs. By comparison with the large production plants run by enterprises in the actual parks, the ICs are usually single buildings housing a relatively small number of start-up businesses. They are, accordingly, far smaller concerns. This gives the science parks an interesting duality. While the incubators in comparison make negligible contributions to output they were created and maintained with the main intention of nurturing new technology-based enterprises. The implication of this is that, since ICs' limited resources are hardly worth of being redirected to efficiently attract inward investment or expand production capacity, they have been exempted from local governments' expropriation and thus being preserved under the policy duality. However, the local governments' indifference and their particular near-sighted behavioral pattern (Oi, 1995) inevitably leave these ICs isolated from the local context, where local entities except for the government have no power or resources to interact with the ICs. At this point, Chinese ICs appear to experience the same sufferings of the BICs in Europe, which have been regarded as airborne incubators directly sponsored and supervised by EU and immediately lost the impetus from local coalitions after losing their initial EU funding (Aernoudt, 2004)

Although ICs have been advertised as the innovation basis of the parks and the main medium in China of supporting new technology-based firms as well as commercializing scientific discoveries to cultivate new sources of economic growth (Harwit, 2002; Lalkaka, 2003), it should be cautioned that it is hard to know how effective these incubators have been. There remain few truly spectacular growth stories, and it is still unclear what the success rate of firms is after graduating from the incubators. In the context of the development of small technological enterprises in China, their contribution can still only be considered negligible. In fact, millions of small enterprises have already emerged in China without the preferential treatment or direct cost to the state incurred by those in incubators. Moreover, in terms of their contribution to the commercialization of technology and development of new high growth sectors, the purpose for which they were created, it remains as yet too early to reach any definitive judgment regarding their contribution.

Conclusion

Over the last two decades, science parks and business incubators experienced a rapid growth in China, where the former have contributed a rather significant share in industrial production and become strong magnets for FDI, and the latter remain heavily dependent on comprehensive supports from the central government and disconnected from local milieu. Though their presence as an attempt to foster technological entrepreneurship might seem to represent an element of convergence with western development patterns, consistent with the process of market liberalization underway in the country, the form taken by technological entrepreneurship governance in China has been very different from any observed in the West. Two key hallmarks have been: varying targets in accordance with the central government's economic strategy at the macro-level; and exclusive influence from the local officials at the micro-level without participation of other entities. Both reflect the asymmetric character of rescaling in the Chinese governmental structure with some real devolution of economic and fiscal responsibilities being accompanied by a

firm insistence on the centralization of political control in Beijing and in Communist Party apparatus. The pattern of outcomes – including the neglect of restructuring China's innovation system and paving the way for the commercialization of indigenous innovations – also seems to have less in common with those identified in the West, where science parks in principle exclude the manufacturing side of business and are supposed to act as zones for innovation and cooperation among R&D, industry and education.

More specifically, it should be noted that there is no single 'western' model of science parks and business incubators. As has been shown in Section 2, European practice in this field still differs a lot from the characteristic American model. Chinese practice, though quite distinct from either, actually echoes in different ways both European and North American forms of governance: the European in the way that a prominent influence from the central state's leadership and direction; and the American in the active, spontaneous devotion of the local economic and social systems although in the Chinese case, local governments' interests prevail over the others.

From the point of view of innovation system reform, science parks and business incubators in China have been a disappointment, especially in terms of their incapability to construct a supportive interface for domestic technology innovation and create synergies among local entities. However, this is not to say that from other perspectives they have not been a success. As with a number of other economic reforms, policy makers have adopted a highly pragmatic approach. The policies to govern science parks and business incubators in China have thus evolved to meet real but changing demands. For instance, the parks had quickly integrated into China's trade strategy, which is undoubtedly a success in the international competition for attracting high quality inward investment. The ICs, though hardly interact with local entities so far, stand for an explicit commitment to the role of the domestic small private enterprises in the development of high-tech industries and China's indigenous technology competitiveness while persistent efforts are being made to rectify their

weaknesses. Soon, given the country's steadily updated comparative advantage, a newly evolved governance model for science parks and business incubators might be anticipated, based on its recently surfaced strategy to build 'an innovative state' (Zheng and Chen, 2006).

Notes

[1]. The oldest science park in the USA is the Stanford Research Park, established in 1951. The first business incubator, created in 1956, was situated in Batavia.

[2]. It was named after the date of its establishment, March 1986.

[3]. With the global proliferation of such parks, various names and models emerged. Science parks are often referred to as 'research parks', 'technology parks', 'technoparks' and 'technopoles'. In the Chinese case, new variants include 'science and technology industry parks' and 'high- and new-technology industry development zones' (Ma and Goo, 2005).

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Table 1 Development of China's Science Parks

Year	Output value (billion dollars)	Ratio in total High-tech output (%)	Export value (billion dollars)	Ratio in total High-tech export (%)
1995	16.9	34.5%	2.9	21.6%
1996	25.8	43.8%	4.3	N/A
1997	37.5	52.1%	6.5	N/A
1998	52.2	60.9%	8.5	34.5%
1999	68.4	69.0%	10.6	36.4%
2000	100.0	79.5%	19.0	46.4%
2002	186.9	97.6%	32.9	45.2%
2003	252.7	98.2%	51.0	46.4%
2004	331.9	98.9%	82.3	45.9%
2005	352.1	84.3%	111.6	52.0%
2006	448.3	85.5%	136.1	46.4%

Source: China Statistic Yearbook on High Technology Industry (1995-2007), National Bureau of Statistics